

## PATENT ABSTRACTS OF JAPAN

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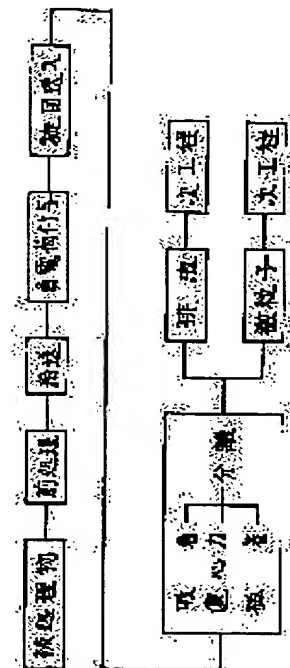
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## (54) METHOD AND DEVICE FOR SOLID-LIQUID SEPARATION

## (57) Abstract:

PROBLEM TO BE SOLVED: To separate fine particles from liquid to be treated mixed with the fine particles by a combination of electrostatic attraction, centrifugal force and magnetic attraction.

SOLUTION: The liquid to be treated mixed with solids is imparted with negative charge, then it is fed from the upper part of the inside of a vertical cylinder and is turned and dropped, and also is applied with centrifugal force, thus the solids contained in the liquid to be treated are moved to the inner wall side of the cylinder, and also, a positive electrode is placed in the vicinity of the inner wall of the cylinder and the solids carrying negative charge are attracted. The cylinder is placed in the magnetic field and the magnetic body in the solids is attracted to the cylinder, and the solids adsorbed and attracted are dropped with their empty weights, and are taken out from the lower part of the cylinder, and the liquid from which the solids are separated is ascended in the central part of the cylinder and is discharged.



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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention gives a charge to the solid-state (henceforth a particle) currently mixed in a liquid, and relates to the solid-liquid-separation method and equipment aiming at \*\* which separates the particle in a processed liquid continuously by electric adsorption, the centrifugal force by making it circle in a processed liquid, and the \*\* arrival by the magnetic field.

[0002]

[Description of the Prior Art] The centrifugal separator for online within a magnetic field is known conventionally (JP,61-222560,A). Moreover, the screw decanter which separates solid-liquid is known by high-speed rotation (JP,4-40878,A).

[0003]

[The technical problem which it is going to solve by invention] Conventionally [ said ], in the centrifugal separator for online, in the seal way, Rota is rotated by magnetism, it is invention which enabled it to perform required separation, and magnetism is used for rotation of Rota.

[0004] Moreover, although the screw decanter constituted so that high-speed rotation might separate solid-liquid was used as a solid-liquid separator of various liquid, there were few differences of the specific gravity of a liquid and a particle, or 10 micrometers of particles were an ultrafine particle as follows, or the centrifugal force which requires the viscosity of a liquid for a particle, an EQC, or when large, it had the trouble which becomes insufficiently [ separation of a particle ], or difficult to separate the particle in a liquid.

[0005] Furthermore, although the particle adhering to the wall of a tumbling barrel was brought together in the 1 side and discharged by the screw, it also had troubles, like there is a possibility that the wear powder of a screw etc. may be involved in a liquid.

[0006]

[Means for Solving the Problem] This invention gives a negative charge, make it stick to a positive electrode, and it was made to adhere to a cylinder wall using centrifugal force, and carrying out \*\* arrival of the magnetic particle by generation of a magnetic field further etc. made solid-liquid separate in synthesis, and it solved said trouble for it.

[0007] Namely, after invention of a method gives a negative charge to a processed liquid which mixed a solid, while supplying and carrying out the revolution descent of it from the upper part in a cylinder of a vertical mold While moving a solid which gave centrifugal force and was contained in a processed liquid to a wall side of said cylinder Set a positive electrode near the wall of said cylinder, and make a solid electrified [ said ] adsorb, and boil said cylinder in a magnetic field and it is set. A liquid which \*\* arrival of the magnetic substance in a solid was carried out, and said solid which carried out adsorption and \*\* arrival was dropped with a self-weight, and separated drawing and said solid from the lower part of said cylinder is the solid-liquid-separation method characterized by raising a center section of said cylinder and discharging. Moreover, in the cylindrical upper part, in order to supply downward [ slanting ] from a tangential direction and to give centrifugal force to a liquid, a processed liquid which mixed a solid rotates a stirring rod within a processed liquid, or rotates a cylinder.

[0008] Moreover, invention of other methods is the solid-liquid-separation method characterized by changing conditions of adsorption of a solid and \*\* arrival, and repeating an aforementioned separation method two or more times.

[0009] Next, while invention of equipment constructs a cylinder perpendicularly, connects aslant [ downward ] a liquid supply pipe which has a negative charge grant means to the upper part of this cylinder from a tangential direction, inserts an effluent cylinder in a machine frame to a center section of said cylinder and carries out the opening of the lower limit to it in the lower part in a cylinder Approach said cylinder wall, prepare a positive electrode, and a end face of drainage tube is connected with the upper part of said effluent cylinder. Form a discharge means in the lower part of said cylinder, and a rotation means to give centrifugal force to a processed

liquid fed in said cylinder is established. It is the solid-liquid separator characterized by equipping an outside of said cylinder with a coil for magnetic field generation, and a negative charge grant means inserts an electrode into a liquid supply pipe, and impresses negative voltage to this electrode. Furthermore, invention of other equipments fixes a stirring rod to the axis of rotation which inserted a rotation means in an effluent cylinder inside. Let a discharge means be a rotary valve.

[0010] In said invention, in order to classify a particle mixed in a liquid for every property of that, this invention is connected with two or more tandems, conditions of voltage and others are changed for every production process, and individual separation is carried out by using current and voltage corresponding to that separation condition. That is, since quality of adsorbate and \*\*\*\*\* differs, processing corresponding to this is rational. For example, separation processing can be carried out separately and Pb, zinc, silver, nickel, lithium, etc. can be collected.

[0011] Although this invention separates solid-liquid and makes a particle adhere to a cylinder wall (or electrode) by comprehensive processing of giving a charge to a particle, giving centrifugal force, carrying out \*\* arrival If an adhesion layer of a particle becomes thick while becoming a revolution style and flowing, balance of adhesion force (adsorption power, \*\*\*\*\*, etc.) and other external force (a liquid flow, gravity) will collapse with necessary, a direction of gravity applied to \*\*\*\*\* at last becomes large, self-weight descent will be carried out and a processed liquid will collect to the cylindrical lower part. Then, only a particle is discharged using a rotary valve etc.

[0012] When the viscosity of a processed liquid in the above is large, migration of a \*\*\*\*\* particle is made easy for a means of warming or dilution, and others. Moreover, in processing fine particles, water of optimum dose is added, a fluidity (for example, 80% - 90%) and dispersibility are given, and it considers as said processed liquid. Although processing efficiency by this invention becomes settled with capacity of equipment and precision becomes settled according to processing conditions, since a high voltage, a high magnetic field, a huge separation cylinder, etc. serve as indispensable requirements for making it high degree of accuracy generally, it is necessary to take into consideration a property of a processed liquid, demand sharpness of separation, etc., and to cope with it rationally.

[0013] In the above, the above may be together used with a method of carrying out individual classification of the particle which separated various particles at once and was subsequently separated, and a method of carrying out individual separation by this invention. For example, it is easier for material with near charge property, magnetic strength, specific gravity, etc. to turn an individual exception, after carrying out mixed separation.

[0014]

[Embodiment of the Invention] This invention is each separation method which separation efficiency was bad, or has improved inaccurate separation, and gave practicality if independent by centrifugal separation, charge separation, and magnetization separation, after giving a charge to the processed liquid which mixed the particle.

[0015] This invention constructs a cylinder in a magnetic field, and assists revolution of a processed liquid, and installs inside a rotation means to give centrifugal force while feeding it so that a means to give a negative charge before feeding of a processed liquid may be established and it can circle in a processed liquid into the cylinder of the vertical mold which carries out centrifugal separation in order to enforce said method. Moreover, while establishing an effluent means into a cylinder, the discharge means of a separation particle is established and consecutive processing is made possible.

[0016]

[Example 1] The example of this invention is explained based on drawing 1 and 2. Warming or moisture adjustment is pretreated to the processed liquid which mixed the particle, and, subsequently quantum feed is carried out with a pump. It is in the middle of this feed, and a charge is given to a particle.

[0017] Subsequently, revolution feeding of the processed liquid is carried out into the cylinder for separation. Erection construction of said cylinder is carried out, and like a cyclone, a processed liquid is accepted from the upper part, and while carrying out the revolution descent of the processed liquid, it separates solid-liquid. While the particle by which it was electrified is adsorbed to a positive electrode in the meantime, \*\* arrival of the magnetic particle is carried out by the magnetic field to a cylinder wall, and all particles adhere to a cylinder wall in response to centrifugal force further.

[0018] That is, according to adsorption power, \*\*\*\*\*, and centrifugal force, each particle will compound and commit centrifugal force, and adsorption power and \*\*\*\*\*, although it moves according to the larger force.

[0019] As mentioned above, the comprehensive-like operation of adsorption power, centrifugal force, and the \*\*\*\*\* is carried out, and even if they are the particle or the comparatively large particle which must have been separated if independent, they are separated easily and quickly.

[0020] Since the adhesion force (adsorption power, centrifugal force, \*\*\*\*\*) in the above produces imbalance with a self-weight inevitably with \*\*\*\*\* and the adhesion layer of a particle carries out self-weight

descent, the particle of a positive electrode side and a cylinder inside descends with adhesion, and continuation separation is performed smoothly and rationally.

[0021] Since mechanical legal force does not act on migration of the particle in said cylinder, there is also no possibility that a new particle may occur by wear (it is (for example, like screw use)). Therefore, continuation separation of long duration high efficiency can be performed.

[0022]

[Example 2] The example of the equipment of this invention is explained based on drawing 2, and 3 and 4. the cylinder 2 for separation to a machine frame 1 -- length -- constructing -- the upper part 1 side of this cylinder 2 -- the tip of the liquid supply pipe 3 -- the shape of a tangent -- and a downward inclination is made to carry out a connection opening, and the interior of the electrode 4 for negative charge grant is carried out into said liquid supply pipe 3. It pierces through top plating 2a, insertion installation of the effluent cylinder 5 is carried out, and the center section of said cylinder 2 is made to carry out the opening of the lower limit of this effluent cylinder 5 in the lower part of said cylinder 2. The above inserts in the axis of rotation 6 in the effluent cylinder 5, while the upper limit of this axis of rotation 6 makes it connect with the driving shaft 8 of a motor 7, the end face of a stirring rod 10 is fixed to the lower limit of the axis of rotation 6 through an arm rod 9, and erection installation of this stirring rod 10 has been carried out upwards in parallel with the axis of rotation 6. The lower part of said cylinder 2 is used as the discharge cylinder 11 formed in the shape of a reverse cone, connects an exhaust pipe 12 with the discharge cylinder 11, and infixes a rotary valve 13 in this exhaust pipe 12. The drainage tube 14 is connected with the upper limit section of said effluent cylinder 5, the outside of said cylinder 2 is equipped with the coil 15 for magnetic field generation, and the positive electrode 16 is installed inside the cylinder 2. 17 in drawing is the static electricity generator and a power supply for coils in 18.

[0023] In said example, since it will be fed downward [ tangent-and ] from the up side wall of a cylinder 2 like \*\*\*\* 20 after a negative charge is given to a processed liquid by the negative electrode 4 if a processed liquid (for example, crude oil) is warmed at about 500 degrees C and it supplies into the liquid supply pipe 3 like \*\*\*\* 19, it descends, circling in the inside of a cylinder 2 on a spiral. If the feather motor 7 is put into operation, since the axis of rotation 6 will be rotated through a driving shaft 8 and a stirring rod 10 will be rotated through the arm rod 9 of the lower limit of the axis of rotation 6 on the other hand, centrifugal force is given to a processed liquid. Although the rotational frequency of said axis of rotation 6 changes with length of the arm rod 9 which fixes the property and stirring rod 10 of a processed liquid, it is usually set to 2000 - 4000rpm. The hand of cut in this case is the direction of drawing 3 Nakaya \*\* 21 (the revolution direction of the fed processed liquid), and promotes the revolution force. The particle with the negative charge in the processed liquid which is the above, and makes and carries out revolution descent is adsorbed by the positive electrode like \*\*\*\* 22, \*\* arrival of the particle which has magnetism is carried out to a cylinder wall like \*\*\*\* 23, and a nonmagnetic particle is forced on a cylinder wall by centrifugal force.

[0024] In the above, if, as for adsorption, \*\* arrival, or the forced particle, the adsorption power (or \*\*\*\*\*) to a positive electrode or a cylinder wall becomes below weight, a particle 25 will carry out self-weight descent like \*\*\*\* 24 with a self-weight, and will collect into the discharge cylinder 11. If a rotary valve 13 is rotated in the direction of \*\*\*\* 26, since the particle which collected in said discharge cylinder 11 will be discharged like addressing \*\*\*\* 27 to the specified quantity, it sends this to degree production process. Moreover, like \*\*\*\* 28 and 29, in the effluent cylinder 5, close goes up, and the effluent which separated the particle discharges it like \*\*\*\* 30 from the drainage tube 14, and is sent to degree production process (effluent processor).

[0025] If electricity is transmitted to the coil 15 in the above, the magnetic particle in a particle will carry out \*\* arrival to the wall of a cylinder 2. In this case, the material which carries out \*\* arrival is controllable by regulating the amount of current passed in a coil.

[0026] Since the magnetic field strength with said coil 15 is 500Ax1000T, it changes current and can adjust \*\* and magnetic field strength. Or although electrostatic voltage is 50,000V, it can sort out the particle by which adsorption or \*\* arrival is carried out by changing this. Therefore, the equipment of said example is connected with a tandem, and if it enables it to separate a different particle corresponding to the separation purpose, the need of re-classifying a separation particle can be lessened.

[0027]

[Effect of the Invention] According to this invention, there are many effects, like electrostatic adsorption, \*\* arrival, and since centrifugal force adhesion is carried out and comprehensive separation processing is carried out, while centrifugal separation can separate the difficult particle at ease and high effectiveness conventionally, separation from a viscous large liquid can also be made comparatively easy about the processed liquid which mixed the particle.

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## CLAIMS

## [Claim(s)]

[Claim 1] After giving a negative charge to a processed liquid which mixed a solid, while supplying and carrying out revolution descent from the upper part in a cylinder of a vertical mold While moving a solid which gave centrifugal force and was contained in a processed liquid to a wall side of said cylinder Set a positive electrode near the wall of said cylinder, and make a solid electrified [ said ] adsorb, and boil said cylinder in a magnetic field and it is set. A liquid which \*\* arrival of the magnetic substance in a solid was carried out, and said solid which carried out adsorption and \*\* arrival was dropped with a self-weight, and separated drawing and said solid from the lower part of said cylinder is the solid-liquid-separation method characterized by raising a center section of said cylinder and discharging.

[Claim 2] A processed liquid which mixed a solid is the solid-liquid-separation method according to claim 1 characterized by supplying downward [ slanting ] from a tangential direction in the cylindrical upper part.

[Claim 3] A solid-liquid-separation method according to claim 1 characterized by rotating a stirring rod within a processed liquid, or rotating a cylinder in order to give centrifugal force to a liquid.

[Claim 4] A solid-liquid-separation method characterized by changing conditions of adsorption of a solid and \*\* arrival, and repeating a separation method according to claim 1 two or more times.

[Claim 5] While constructing a cylinder perpendicularly, connecting aslant [ downward ] a liquid supply pipe which has a negative charge grant means to the upper part of this cylinder from a tangential direction, inserting an effluent cylinder in a machine frame to a center section of said cylinder and carrying out the opening of the lower limit to it in the lower part in a cylinder Approach said cylinder wall, prepare a positive electrode, and a end face of drainage tube is connected with the upper part of said effluent cylinder. A solid-liquid separator characterized by having formed a discharge means in the lower part of said cylinder, having established a rotation means to give centrifugal force to a processed liquid fed in said cylinder, and equipping an outside of said cylinder with a coil for magnetic field generation.

[Claim 6] A negative charge grant means is the solid-liquid separator according to claim 5 characterized by inserting an electrode into a liquid supply pipe and impressing negative voltage to this electrode.

[Claim 7] A rotation means is the solid-liquid separator according to claim 5 characterized by fixing a stirring rod to the axis of rotation inserted in an effluent cylinder inside.

[Claim 8] A discharge means is a solid-liquid separator according to claim 5 characterized by considering as a rotary valve.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] The block diagram of the example of the method of this invention.

[Drawing 2] The cross section which similarly omitted a part of example of equipment.

[Drawing 3] The plan which similarly omitted the part.

[Description of Notations]

- 1 Machine Frame
- 2 Cylinder
- 3 Liquid Supply Pipe
- 4 Negative Electrode
- 5 Effluent Cylinder
- 6 Axis of Rotation
- 7 Motor
- 8 Driving Shaft
- 9 Arm Rod
- 10 Stirring Rod
- 11 Discharge Cylinder
- 12 Exhaust Pipe
- 13 Rotary Valve
- 14 Drainage Tube
- 15 Coil
- 16 Positive Electrode
- 17 Static Electricity Generator
- 18 Power Supply for Coils
- 25 Particle

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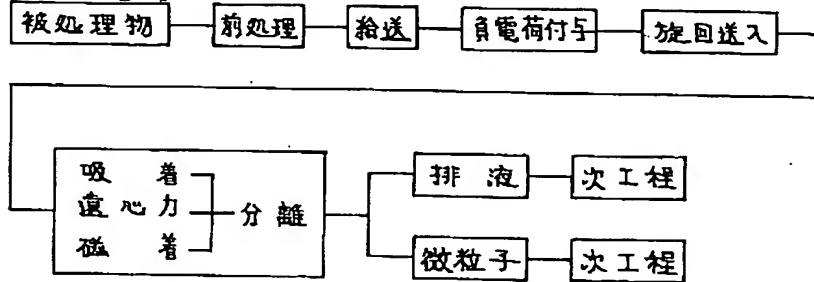
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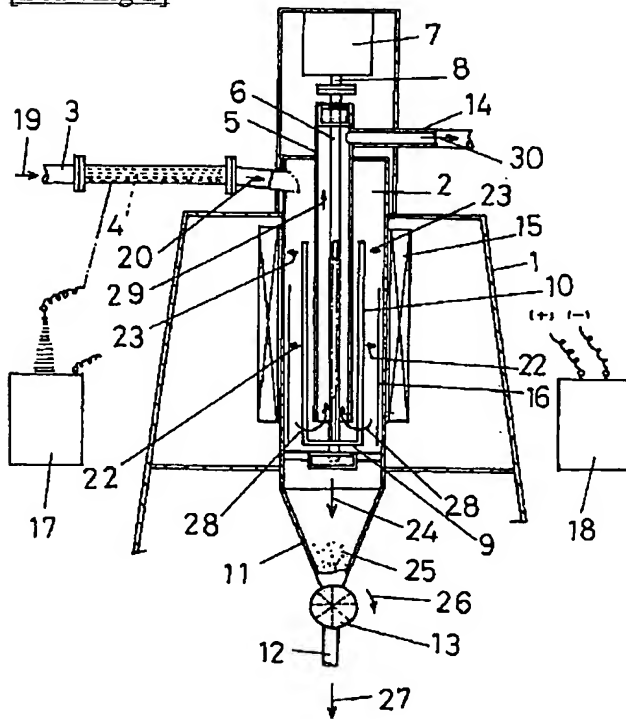
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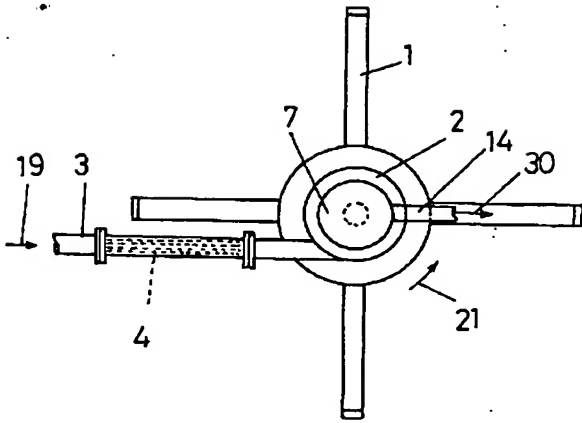
[Drawing 1]



[Drawing 2]



[Drawing 3]



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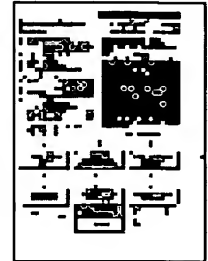
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Abstract:

**PROBLEM TO BE SOLVED:** To separate fine particles from liquid to be treated mixed with the fine particles by a combination of electrostatic attraction, centrifugal force and magnetic attraction.

**SOLUTION:** The liquid to be treated mixed with solids is imparted with negative charge, then it is fed from the upper part of the inside of a vertical cylinder and is turned and dropped, and also is applied with centrifugal force, thus the solids contained in the liquid to be treated are moved to the inner wall side of the cylinder, and also, a positive electrode is placed in the vicinity of the inner wall of the cylinder and the solids carrying negative charge are attracted. The cylinder is placed in the magnetic field and the magnetic body in the solids is attracted to the cylinder, and the solids adsorbed and attracted are dropped with their empty weights, and are taken out from the lower part of the cylinder, and the liquid from which the solids are separated is ascended in the central part of the cylinder and is

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